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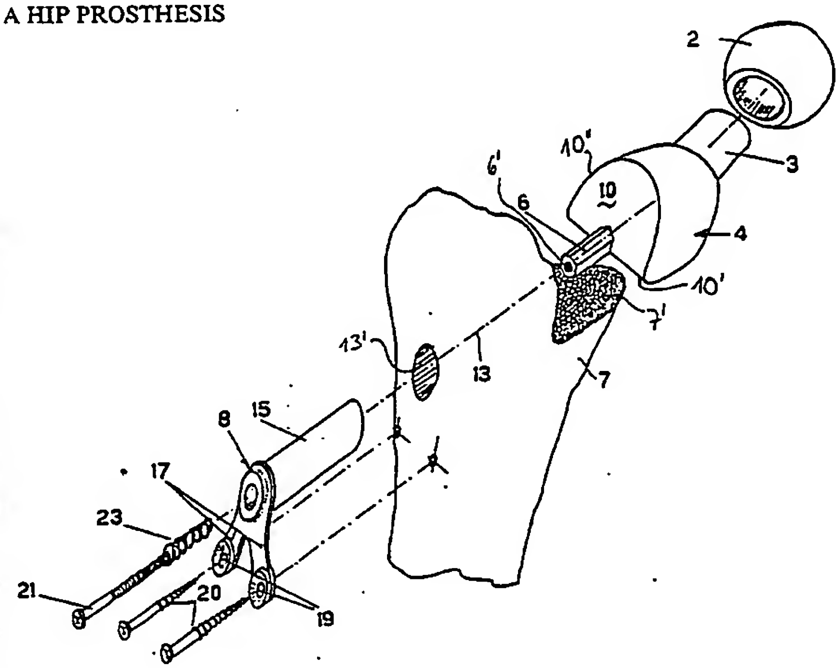
(54) Title: JOINT MEMBER FOR A HIP PROSTHESIS

(57) Abstract

Joint member for a hip prosthesis comprising a joint head, a supporting portion including a supporting surface co-operating with a corresponding supporting surface on the proximal femur and fixation means for securing joint head and supporting means to the femur, characterized in that a shankless and block-like supporting member (4, 41) includes at least a supporting surface (10, 11, 43, 44) disposed adjacent the joint head (2, 40) such that the corresponding femur supporting surface (7″, 7′) is adjacent the proximal medical femural cortex, in that further retaining means (15, 21) are provided coacting with the proximal femur (7) and engaging the supporting member (4) through a bore (13′) in the femur supporting surface (7″) in order to exert a tensile force on the supporting member (4) laterally to press the supporting surface (10, 11) against the femur supporting surface (7″, 7′), and in that means are associated with the supporting member (4) and/or with the retaining means to prevent a rotation of the supporting member (4) approximately about the axis of the femur neck.



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Joint Member For A Hip Prosthesis

In femoral joint members of conventional hip prostheses the joint head is connected via a joint neck to a shank adapted to be introduced in the medullary canal of the femur. The elongated shank which is wedge-like in the lateral-medial plane is either secured in the femur by a jamming effect and/or by means of bone cement. In both cases the medullary canal has to be prepared by a drilling operation in order to allow the insertion of the shank. A flange-like collar between the prosthesis neck and the shank engages a corresponding surface of the proximal femur and serves for the support of the prosthesis. The force transfer from the joint head of the prosthesis to the femur substantially takes place through the prosthesis shank.

Follow-up studies brought about that after a period of ten years after the implantation the loosening rate reaches 35% of the patients operated. Patients operated on before the age of 30 years sustain a loosening of up to 57% within the five years following the implantation. Loosened prostheses cause pain and require hazardous reoperations.

The main reason for the loosening of the prostheses is seen in the different modulus of elasticity of the bone material and the prosthesis shank, respectively. Due to oscillating loads so-called micro movements occur in the prosthesis shaft leading to a micro-fatigue fracture at the interface of both materials.

The stress pattern of the normal femur changes by the implantation of a prosthesis.Portions of the femur normally

allowing extreme loads are not loaded in the same amount after a prosthesis has been implanted. Consequently a remodeling of the bone structure happens which also contributes to a loosening of the prosthesis. Additionally, the drilling operation for the insertion of the shank considerably weakens the portions above the proximal medial femural cortex which normally has a high load capacity.

Attempts have been made to obviate the mentioned problems by allowing an ingrowth of bone material in corresponding parts of the prosthesis. For this purpose the surface of the prosthesis is provided with irregularities, openings or the like or by developing a bone cement such that it allows an ingrowth of the bone material. These attempts are not completely satisfactory.

The invention is based on the problem to provide a hip prosthesis which allows an appropriate introduction of force into the femur and which does not lead to a loosening after a long period of time and which does not lead to undesired deformation of the femur.

The joint member according to the invention includes a block-type supporting member. A prosthesis shank as usual with conventional femoral prostheses is not provided. The block-type shankless supporting member includes at least one supporting surface which is located adjacent to or a small distance from the joint head such that the corresponding femur supporting surface is positioned adjacent the proximal medial femural cortex. By means of suitable retaining means which coact with the supporting member through a bore in the femur-supporting surface the supporting

member is fixedly drawn or pressed against the femur-supporting surface. The retaining means is not provided for bearing the load to which the joint head is subjected,rather, it serves substantially the purpose of pressing the support member fixedly against the supporting surface of the femur.The transfer of force from the joint head to the femur is intended to take place immediately through the supporting surface(s). Suitable means on the supporting member or on the retaining means prevent a rotation of the supporting member approximately about the axis of the femur neck. Above all,after the operation, when the supporting member and the femur are not grown together there is a danger that the supporting member rotates or tilts. Retaining means and antirotation means prevent a tilting and rotating without substantially contributing to the introduction of force into the femur.

The retaining or fastening means thus, above all, serves for the primary supply after the replacement of the hip joint. After supporting member and femur have grown together the retaining means can be removed if desired.

An antirotational effect for the supporting member can be achieved in that the supporting member and the retaining means are provided with co-operating surfaces which prevent rotation of the supporting member. Additionally or alternatively the supporting surface on the supporting member can be oriented such that a torsion or rotational force on the supporting member about approximately the axis of the femur neck results in a component normal to the femur supporting surface. With such a supporting surface on the supporting member a rotational force thereon would lead to a spreading of the supporting surfaces of the supporting member and

the femur. This would cause considerable forces which are effective as counter-forces relative to the rotational forces possibly effective on the supporting member.

It is preferred to have first and second supporting surfaces on the supporting member which include an angle between each other, preferably a right angle. One supporting surface extends approximately perpendicularly to the femur axis while the other extends approximately in parallel to the femur axis. During the operation a corresponding V-shaped cut is made in the proximal femur. The complementarily formed supporting member is positively inserted in the cut. The supporting surface extending substantially parallel to the femur axis preferably has a length in this direction which is of 2/3 of the length of the extension of the supporting surface transverse to the femur axis. It is not necessary that the mentioned supporting surfaces are plane, rather, they could be composed of subsurfaces which include angles between them. Further, the supporting surfaces can be provided with elevations, indentations, recesses or the like for the ingrowth of bone material. It is particularly preferred if the supporting surface is defined by the end faces of a plurality of spaced webs, ribs or the like. Such ribs or webs are preferably formed in the portion of the supporting surface from which the force is transferred approximately in the axial direction to the femur. Such supporting webs or supporting ribs have two main functions. One relies on the fact that during the healing process a sufficient amount of bone substance can grow between the webs in order to achieve an intimate connection of the support member with the femur in order to allow the transfer of all forces from the joint head to the femur. The second function is defined by a certain resiliency of the webs. Thus, no rigid prosthesis

portion borders any much more resilient bone portions. Rather, in this region an adaptation of the resiliencies can be achieved so that the above mentioned fatigue phenomena will not occur. The webs, ribs or the like can be provided with toothings, grooves, holes or the like in order to facilitate the ingrowth of the bone material.

In one embodiment of the invention an extension is provided below the supporting surface of the supporting member, the extension coacting with the retaining means. The extension may include an angle of 30 to 45° to one of the supporting surfaces which include a right angle therebetween. The extension is engaged by the retaining means in order to press the supporting member laterally as described above. The extension is inserted in the femur and can be provided with further means to facilitate an ingrowth of bone material and to achieve an anti-rotational effect. For this purpose a plurality of circumferentially spaced wings or fins can be formed at the extension, the radial ends of the wings being disposed radially inwardly of the associated edge of the supporting surface.

Different suitable retaining means can be used in order to secure the prosthesis according to the invention to the proximal femur. A preferred embodiment provides tensional anchoring means engaging the supporting member, an opposite surface of the anchoring means cooperating with the lateral surface of the proximal femur. The tensional anchoring means may include a screw bolt which can be threaded into a threaded bore of the supporting member and which is slidably guided in a sleeve, a compression spring being located between the head of the screw bolt and the sleeve. Such an arrangement resembles the so-called "Pohl'sche Lasche"

which enables an osteosynthesis of femur neck fractures. By the way it is known to secure a prosthesis head to the femur by such tensional anchoring means. In the known prosthesis a flange is provided at one end of the prosthesis neck which is seating against a respective supporting surface of the femur. In such a prosthesis the main forces are introduced into the femur through the anchoring means. Such force transfer is leading to high surface pressures which also could result in a loosening of the prosthesis.Furthermore, the known prostheses have no means for preventing a rotation of the prosthesis head which may also lead to a loosening. In the invention the tensional anchoring means essentially serves only for a pressing of the supporting member against the femur and do not - or only to a minor extent - contribute to an introduction of force into the femur.

A further anti-rotational effect can be achieved by the mentioned extension being provided with a section having a polygonal cross section, the polygonal section being adapted to be inserted in a complementary socket section of the sleeve of the anchoring means. In this case means have to be provided preventing a rotation of the sleeve.

It is preferred to form the prosthesis of the invention of pure titanium which is particularly biologically compatible to the human body.

The invention will be explained hereinafter by way of some drawings.

Fig. 1 is a schematic perspective exploded view of a first embodiment of the invention

Fig. 2 shows a section through the prosthesis according to Fig. 1 in its implanted state.

Fig. 3 is an exploded view showing the preparation of the femur in order implant the prosthesis according to the invention.

Fig. 4 is a side view of another embodiment of the invention.

Fig. 5 shows a top plan view of the prosthesis according to Fig. 4.

Fig. 6 is a posterior view of the prosthesis according to Fig. 4.

Before going into detail it should be mentioned that each feature to be described may be a part of the invention per se or in connection with the features of the claims.

Figs. 1 to 3 show the proximal portion 7 of a femur which has been provided with a rectangular cut in a manner as to be described later. By the cut a supporting surface 7' is formed extending substantially rectangularly to the femur axis. A further vertical supporting surface 7'' is formed extending approximately parallel to the femur axis. The femur 7 is provided with a throughbore 13' along an axis 13 extending at a small acute angle to the natural femur neck axis.

The femoral prosthesis illustrated in Figs. 1 and 2 comprise a block-like supporting member 4 including a medially extending conical plug 3 which co-operates with the conical bore in a joint ball 2. The supporting member 4 includes two supporting surfaces 10, 11 including a right angle therebetween,the intersection line of the supporting surfaces 10, 11 being rounded as shown at 10'. Near the rounded edge 10' an extension 6 extends from the supporting surface 10 along the axis 13, the extension 6 having a hexagonal cross section. The extension 6 includes a threaded axial bore 6'.The supporting surfaces 10 and 11 are defined by the rounded edge 10' and an arcuate edge 10''. This can be seen in Fig. 2 relative to the supporting surface 10. The supporting surface 11 is formed correspondingly. The supporting member 4 has a rounded external contour between the supporting surfaces 10, 11.

As can be seen in Fig. 2, the supporting member 4 is matched to the cut of femur 7 said cut being defined by the supporting surfaces 7', 7''. As can be seen in Fig. 2 further the length of the supporting surface 10 if viewed in axial direction is 2/3 of the length of the supporting surface 11 if viewed transverse to the femur axis. If the supporting member 4 is inserted in the mentioned cut, the extension 6 is introduced into the bore 13'. A sleeve 15 is introduced into the bore 13' laterally, the sleeve including a socket portion 15' at its interior end portion, the socket portion having a hexagonal cross section. The cross section of the socket portion 15' is such that the extension 6 is matching the socket portion 15'. A screw bolt 21 is introduced in the sleeve 15, the screw bolt 21 being threaded in the threaded bore of the extension 6. A spring 23 is located in an enlargement 25 of the

sleeve bore, one end of the spring 23 is seated against the shoulder of the enlargement, the other end of the spring seating against the lower side of the bolt head. Since the bolt head also is slidingly received by the sleeve the supporting member 4 can move away from the supporting surfaces 7',7" a small amount if engaged by the respective forces. A flange 8 is formed on the lateral side of the sleeve 15, the flange engaging the lateral side of the femur 7. Plate-like extensions 17 are integrally formed with the flange, the extensions 17 being disposed in a bifurcate arrangement and including holes 19 at the ends thereof which receive bone screws 20. The relay, the extension 17 can be fixedly secured to the femur 7 by the bone screws and thus prevent rotation of the sleeve 15.

As can be particularly seen in Fig. 2 the introduction of force from the prosthesis head into the femur 7 takes place essentially through the supporting surfaces 10, 11 and the supporting surfaces 7, 7'', respectively. The femur supporting surface 7' substantially receives the compression forces in the region of the proximal medial femural cortex, while the femur supporting surface 7'' substantially receives the smaller tensional forces. A portion of the tensional forces is also received by the extension 6 and the anchoring means as shown. The anchoring means as shown by which the supporting member 4 is pressed against the supporting surfaces 7', 7'' of the femur is important above all for a primary supply before the supporting member and the femur are grown together. To enhance this effect, the supporting member can be provided with holes, elevations, toothings, indentations or the like. The engagement of the extension 6 with the sleeve 15 contributes to the rotational stability of the supporting member 4 together with the specific orientation of the

supporting surfaces 10, 11.
As can be seen, supporting member 4, extension 6 and tap 3 are integrally formed, e.g. by casting.Preferably pure titanium is used.

The prosthesis member shown in the Figures 4 to 6 comprises a joint ball 40, a supporting member 41 and a hexagonal extension 42. The hexagonal extension 42 is integrally formed with the supporting member 41 and resembles the extension 6 of the embodiment described above. The supporting member 41 includes a supporting surface 43 substantially parallel to the femur axis. A further supporting surface 44 extending perpendicularly to the supporting surface 43 is defined by the plane end surfaces of webs 45 which extend downwards from the solid portion of the supporting member 41 substantially normal to the common plane of the end faces. The external edges of the webs 45 are arranged on an arc (see Fig. 4 in connection with Fig. 6). The axis of the webs parallel to the common plane extends radially to the arc so that the distances between the webs radially inwards are smaller than radially outwards.The surfaces of the webs facing each other are provided with a toothing or with grooves which is not illustrated.The webs further can be provided with holes or the like which is also not shown. As can be seen in Fig. 6 the contour of the supporting surface 43 resembles the contour of the supporting surface 10 of the supporting member 4 according to Figs. 1 and 2. Wings 46 or fins extend from the supporting surface 43, the wings 46 being radially formed at the extension 42.In this embodiment as shown six wings 46 are equally circumferentially spaced.The wings 46 also can be provided with holes, recesses, toothings or the like also at their end faces. Upon implantation the wings are introduced in a corresponding bore in the femur along the axis 13 of Fig. 1.

The implantation of the prosthesis shown in Figs. 4 to 6 is similar to that of the prosthesis according to Figs. 1 and 2. The main difference between the embodiments shown is that in the case of the supporting member 41 the support on the femur supporting surface 7' occurs through "legs" and not through a continuous plane supporting surface 11 according to Fig. 2. The spaces between the webs 45 or the legs enable an ingrowth of bone material during the healing process. The webs 45 further show a larger resiliency than a rigid supporting body. Bone material can also grow between the wings 46 and improve the secure fixation and the rotational stability of the prosthesis as shown. The prosthesis as shown according to Figs. 4 to 6 enables also an intimate ingrowth of the femur bone such that the retaining means as shown in Fig. 2 will be only necessary for the first healing phase, afterwards the retaining means could be removed if desired.

The prosthesis shown in Figs. 4 to 6 is also made preferably of titanium. The surfaces of the prosthesis contacting the bone can be coated with a material which improves the mechanical stability and enhances the ingrowth of bone material. Such a material is for instance tricalcium phosphate ceramic. The porous ceramic has a porosity of for instance 200 to 500 microns. The mentioned ceramic is resorbable, the resorbed ceramic will be slowly displaced by the bone substance.

In Fig. 3 tools are shown which serve for the implantation of the prosthesis according to Figs. 1 and 2 or 4 to 6. In Fig. 3 an Y-like saw guide 71 is shown, the shaft 77 thereof includes a longitudinal slot for a screw 80 for an attachment to a bore gauge for bone screws 85 corresponding to bone screws 20 of

Fig. 1,and for a screw bolt 81 corresponding to the screw bolt 21 which co-operates with a spring 43 corresponding to spring 23 of Fing 1. In the arms of the guide 71 slots are provided forming a right angle. At the intersection of the arms a bore 82 is formed. By means of the slots in the arms 29 the supporting surfaces 7', 7'' are cut in the femur.7. The radius at the intersection line of the supporting surfaces is made by a drilling tool introduced through the bore 82. Thereafter a template 75 for the throughbore 76 is placed in the cut thus formed,the lateral recess thereof co-operating with the shaft of the screw 89 placed in the recess 90 through the bore 82. In this way the bore 13' in femur 7 (see Fig. 1) is formed.

PATENT CLAIMS

1. Joint member for a hip prosthesis comprising a joint head, a supporting portion including a supporting surface co-operating with a correspon- ding supporting surface on the proximal femur and fixation means for securing joint head and suppor- ting means to the femur, characterized in that a shankless and block-like supporting member (4, 41) includes at least a supporting surface (10, 11, 43, 44) disposed adjacent the joint head (2, 40) such that the corresponding femur supporting surface (7'', 7') is adjacent the proximal medical femural cortex, in that further retaining means (15, 21) are provided coacting with the proximal femur (7) and engaging the supporting member (4) through a bore (13') in the femur supporting surface (7'') in order to exert a tensile force on the supporting member (4) laterally to press the supporting surface (10, 11) against the femur supporting surface (7'', 7'), and in that means are associated with the suppor- ting member (4) and/or with the retaining means to prevent a rotation of the supporting member (4) approximately about the axis of the femur neck.

2. The joint member according to claim 1, charac- terized in that on the side of the supporting member (4) opposite to the joint head (2) and on the retaining means co-operating surfaces (6, 15') are formed which prevent a rotation of the suppor- ting member (4).

3. The joint member according to claim 1 or 2, charac- terized in that the supporting surface (10, 11) of

the supporting member (4) is oriented such that a rotational force approximately about the axis of the femur neck exerted on the supporting member results in a force component normal to the femur supporting surface (7').

4. The joint member according to one of the claims 1 to 3, characterized in that at least a first supporting surface (11) extends approximately rectangularly to the femur axis and in that at least a second supporting surface (10) includes an angle to the first supporting surface (11) and extends towards the proximal end of the femur 7.

5. The joint member according to claim 4, characterized in that the first and the second supporting surface (10, 11) intersect each other under an angle of preferably 90°.

6. The joint member according to claim 4 or 5, characterized in that the first and/or the second supporting surface are subdivided in subsurfaces which extend at an angle relative to each other.

7. The joint member according to one of the claims 1 to 6, characterized in that the supporting surface includes elevations, indentations, recesses or the like allowing ingrowth of bone material.

8. The joint member according to claim 7, characterized in that the supporting surface (44) is defined by the end surfaces of a plurality of webs (45),ribs or the like.

9. The joint member according to one of the claims 1 to 8, characterized in that the contour of the outer edge of the supporting surface(s)(10, 11, 43, 44) is arcuately shaped and/or the external surface of the supporting member (4, 41) is rounded.

10. The joint member according to claim 8 or 9,characterized in that the webs (45), ribs or the like are arranged radially relative to the arcuate outer edge.

11. The joint member according to one of the claims 1 to 10, characterized in that below the supporting surface (10, 11) an extension (6, 42) is provided co-operating with the retaining means.

12. The joint member according to claim 11, characterized in that a plurality of radial wings (46) or fins are formed, the radial outer ends thereof are located radially inwardly of the associated edge of the supporting surface (44).

13. The joint member according to claim 8 or 12, characterized in that the surfaces of the webs (45), ribs or the like facing each other and/or the surfaces of the radial wings or fins(46) include holes, grooves, toothings or the like irregularities.

14. The joint member according to claim 12 and 11, characterized in that a section of polygonal cross section is formed on the extension (6, 42), the polygonal section being adapted to be inserted into a complementary socket (15') of the retaining means (15, 21).

15. The joint member according to claim 1, characterized in that the retaining means include anchoring means engaging the supporting member(4),the anchoring means including a counter-surface co-operating with the lateral surface of the proximal femur (7).

16. The joint member according to claim 15, characterized in that the anchoring means include a screw bolt (21) which is adapted to be threaded in a threaded axial bore (6') of the extension (6), the screw bolt being slidably guided in a sleeve (15), a compression spring (23) being located between the head of the screw bolt (21) and the sleeve (15).

17. The joint member according to claim 14 and 16, characterized in that the polygonal section of the extension (6) is adapted to be inserted in a complementary socket portion of the sleeve (15), the sleeve (15) including means which prevent a rotation of the sleeve (15) about the sleeve axis.

18. The joint member according to claim 17,characterized in that plate means (17) are affixed to the sleeve, the plate means being adapted to be positioned against the femur, the plate means (17) including at least one hole for a bone screw (20).

19. The joint member according to claim 1,characterized in that the supporting surface(s) is(are) coated with a material which is at least partially resorbable, for instance by tri-calcium phosphate ceramic.

20. The joint member according to claim 19,characterized in that the pores of the ceramic have a diameter of about 200 to 500 micron.

21. The joint member according to claim 1,characterized in that the supporting member (4, 41) is made of pure titanium (99,99%).

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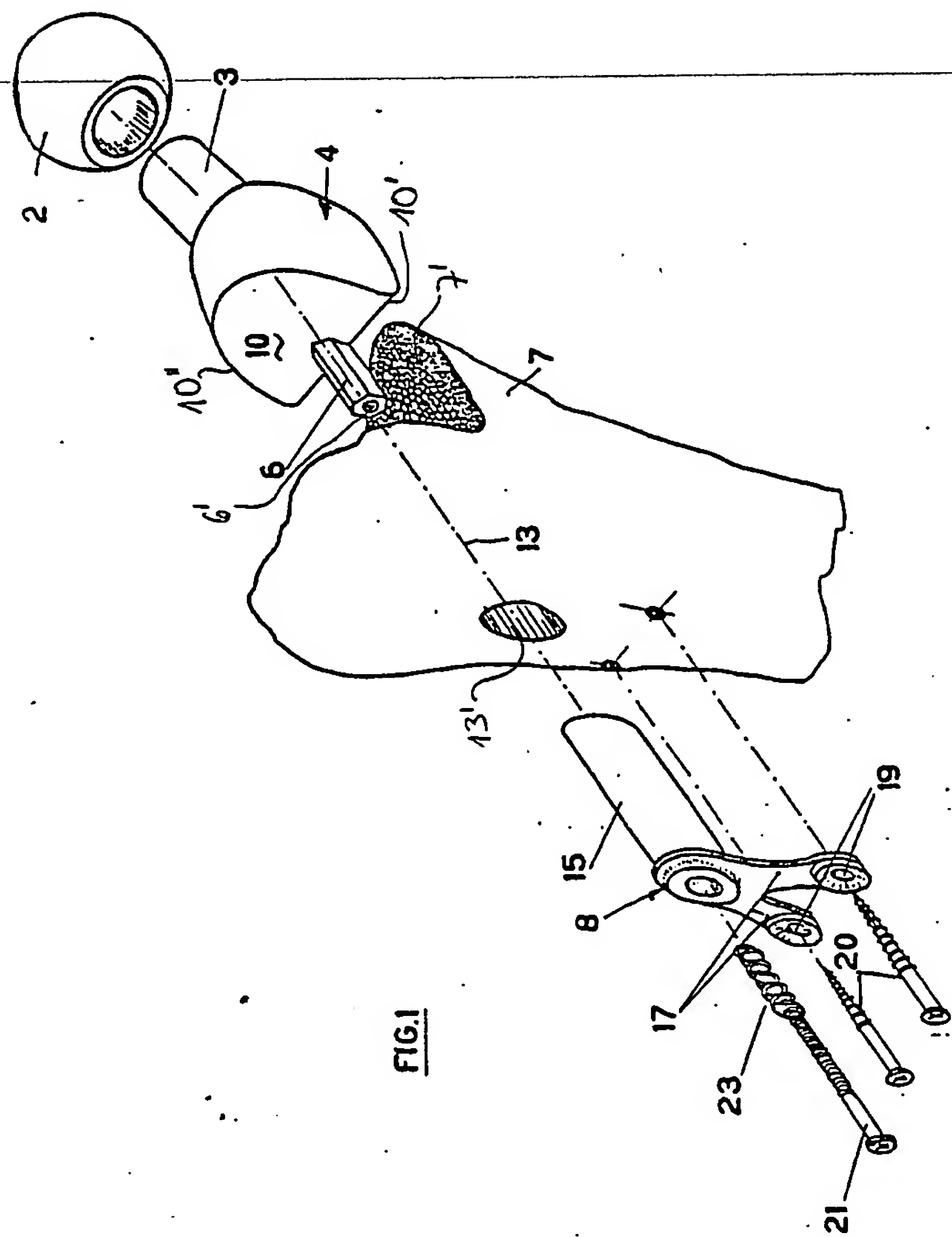

FIG.1

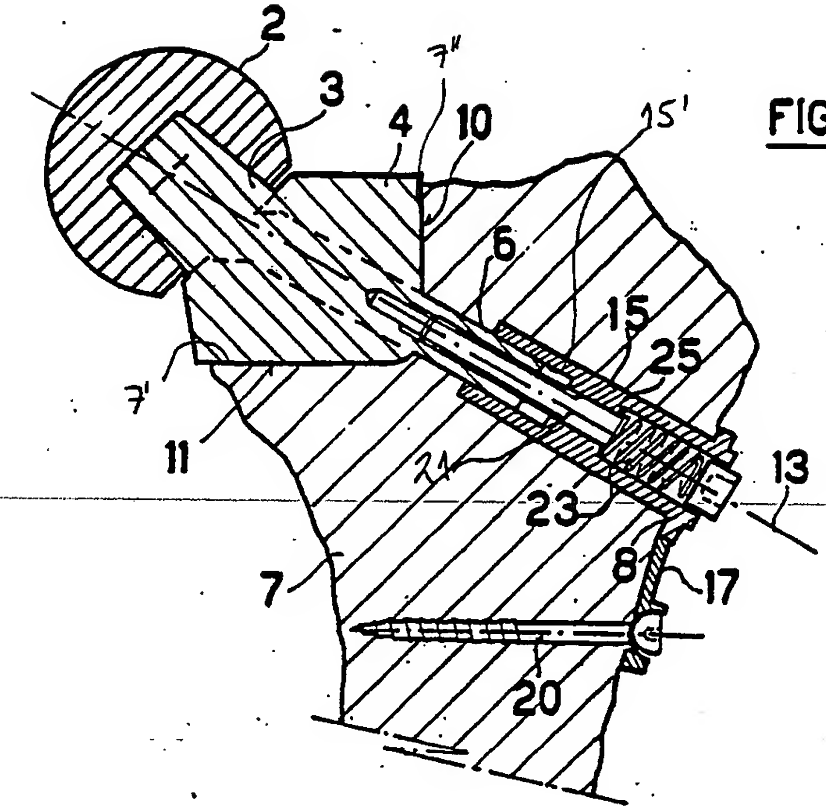

FIG. 2

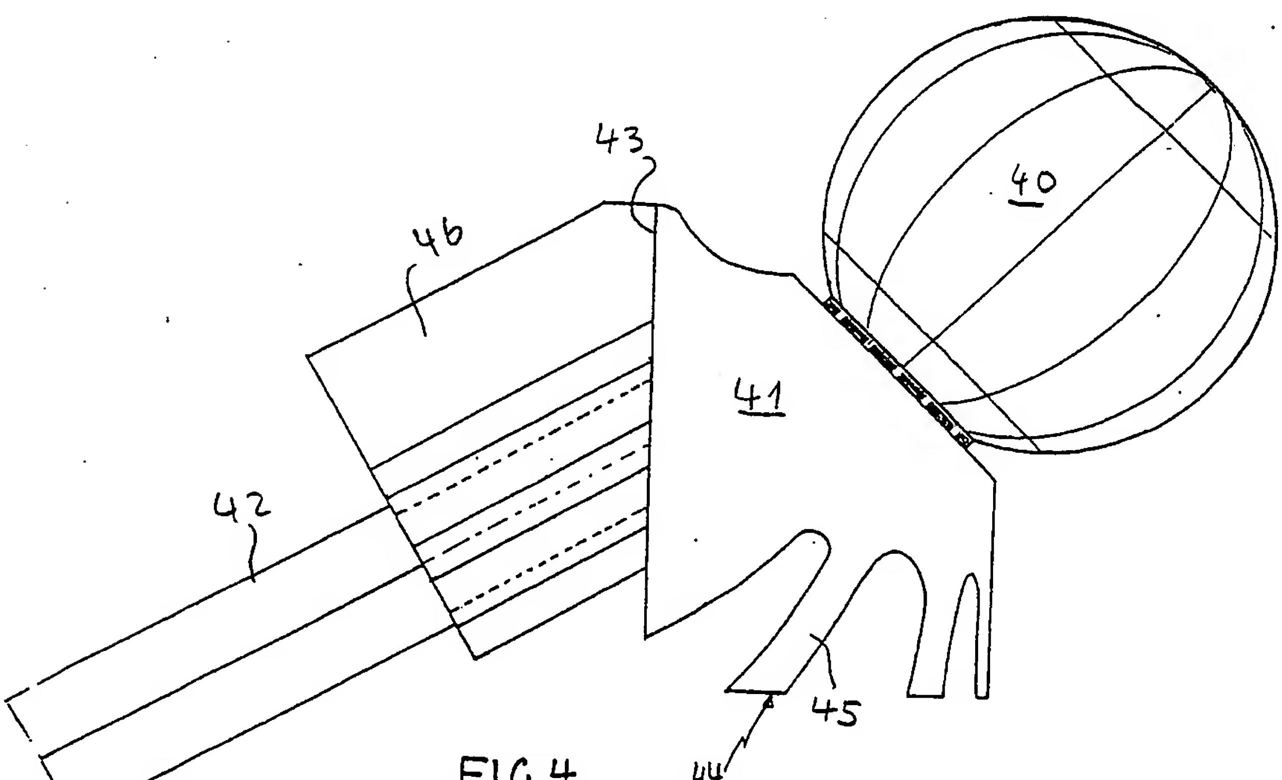

FIG 4

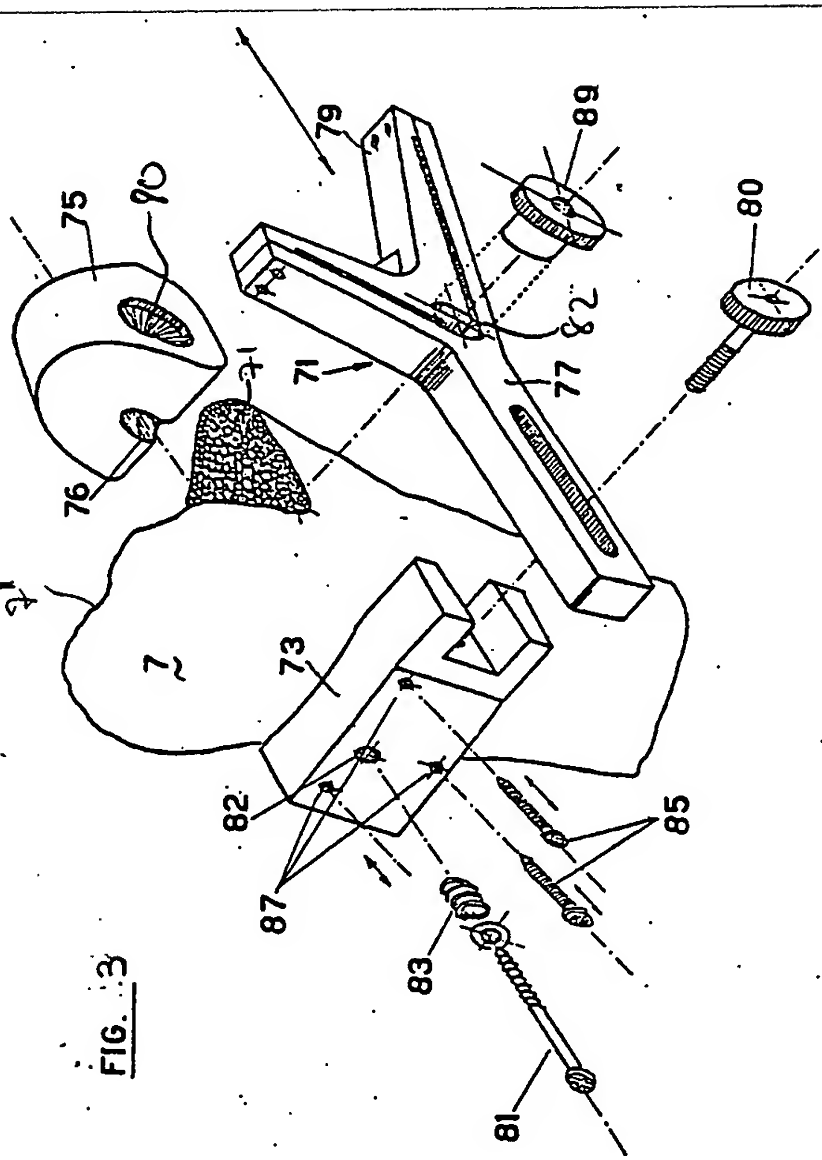

FIG. 3

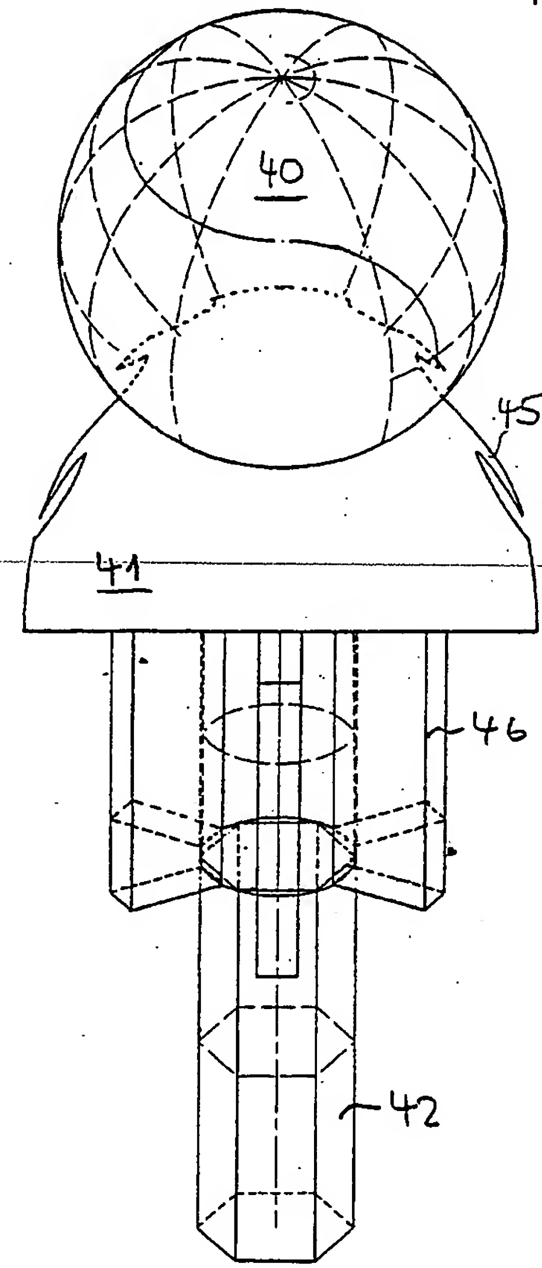

FIG 5

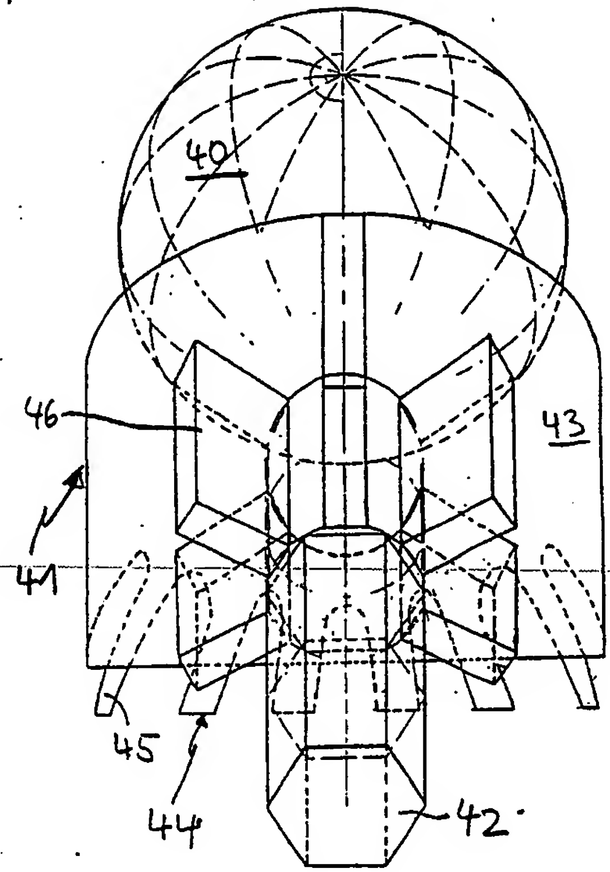

FIG 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 86/00006

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: A 61 F 2/36

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	A 61 F A 61 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A, 0099167 (YAPP) 25 January 1984, see page 4, lines 11-17; figures	1
A	FR, A, 2528307 (DUPUIS) 16 December 1983, see page 2, lines 4-9,31-33; figures	1
A	FR, A, 1046516 (CHEVALIER ET FILS) 8 July 1953, see page 2, left-hand column, lines 1-22; figure 8	1
A	GB, A, 2033755 (RAMBERT et al.) 12 October 1979, see page 2, lines 40-47; figure	1
A	US, A, 4163292 (AVERETT, Jr.) 7 August 1979, see column 2, lines 25-29; figures	1

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11th April 1986	29 AVR. 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/EP 86/00006 (SA 11844)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 21/04/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0099167	25/01/84	JP-A- 58209348 AU-A- 1347483	06/12/83 17/11/83
FR-A- 2528307	16/12/83	None	
FR-A- 1046516		None	
GB-A- 2033755	29/05/80	FR-A,B 2438470	09/05/80
US-A- 4163292	07/08/79	None	

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82